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ABSTRACT

This paper explores the impact of Internet access in schools on teachers' professional lives, experiences, and capabilities. The research was conducted within the context of Common Knowledge: Pittsburgh a project designed as a collaboration between the University of Pittsburgh (Pennsylvania), the Pittsburgh Public Schools, and the Pittsburgh Supercomputing Center that provides supercomputing and technical resources to scientists and researchers throughout the country. The major data-gathering methods were qualitative observations, semi-structured interviews, account holder surveys, and the collection of archival material. Findings related to the following consequences of teacher Internet use are reported: increased work-related communication with others; increased interaction within the school; increased interaction outside of the school; increased opportunities for engagement in professional development activities; increased knowledge of computing and the Internet; home computer purchases by teachers; expansion of the teacher's role outside of the classroom; and increased professional pride and enthusiasm. (Contains 23 references.) (MES)

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Internet Use and Teacher Change

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In recent years the Internet has entered schools in the U.S. at a remarkable pace, accompanied by high expectations about its potential usefulness for students and its likely impact on teachers' pedagogical behavior (Hunter, 1992; Carlitz, 1991). Such outcomes are very important. Indeed, we are currently in the midst of completing a monograph which focuses heavily on such issues (Schofield & Davison, 2000). However, in this paper we explore another possible outcome of Internet access in schools- it's impact on teachers' professional lives, experiences, and capabilities. It is certainly true that many of the changes discussed in this chapter have clear implications for teachers' classroom behavior. Indeed, that is one of the things that makes these outcomes potentially important. However, given the brief time available for our presentation we have chosen to focus on changes in teacher's professional lives quite distinct from their classroom behaviors. Before proceeding to discuss the results of our research on this topic we will briefly describe the context in which the research was conducted and the research methods used.

Common Knowledge: Pittsburgh: Goals and Historical Context

Common Knowledge: Pittsburgh (CK:P) is one of four large scale Internet projects, or Internet "testbeds," funded in the United States by the National Science Foundation (NSF). These projects were designed to explore in very different ways the potential of using wide-area networking in elementary, middle, and high schools. (For additional details on the three other testbed sites, see Hunter (1994), Newman (1994), and Pea (1994)). The project was designed as a collaboration between the University of Pittsburgh, the Pittsburgh Public Schools, and the Pittsburgh Supercomputing Center that provides supercomputing and technical resources to scientists and researchers throughout the country.

CK:P's primary goal was to stimulate teachers in a large urban school system to use the Internet in their work. Specifically, it hoped to encourage teachers at all grade levels and in all subjects to develop varied uses of the Internet in their curricula. Although teachers' professional use of the Internet was valued, the emphasis in CK:P was on encouraging teachers to find ways to incorporate Internet use into students' everyday activities in a wide range of subject areas.

At the same time that CK:P valued having educators develop their own approaches to Internet use, as a project it explicitly wished to promote specific kinds of educational change. Thus, the original grant proposal spoke of the need to find ways to connect teachers and students to the world outside of the school to make the tasks students do in school less artificial and removed from their everyday lives. Further, it spoke hopefully of using the Internet to facilitate active, independent work on the part of students and to enhance equity for students from diverse backgrounds. Thus, the project espoused goals roughly in line with an approach to education that gained many adherences within educational research circles within the past two decades labeled the constructivist approach.

A fundamental fact shaping CK:P was that in spite of the project's substantial budget it did not have anywhere near the financial or human resources needed to bring the Internet to all of the district's classrooms. Thus, groups of educators at district schools had to apply to CK:P for Internet access through an annual competitive process the project developed called the request for proposals (RFP) process. Specifically, interested groups of educators, usually consisting of 5-12 individuals at a given school, submitted proposals detailing how the Internet would be used in the service of curricular and educational goals. Sometimes these projects were focused around a small number of common endeavors undertaken by team members. More frequently, they tended

to describe a larger number of projects designed to be implemented by individual team members or small subsets of team members. A committee made up of parents, school board members, teachers, district personnel, foundational staff, and others chose among these proposals to award access to a specified number of schools each year. Once a group of educators was selected to participate in the project through the RFP they received a substantial amount of educational and technical support as well as the computer resources they needed to realized the proposed Internet project .

During CK:P's five-year lifespan, educators from 29 of the district's 89 schools were selected to participate in the project. The project also provided at least one Internet connection and a lesser amount of support to another fifty-one schools in line with its goal of stimulating Internet use in the district.

Methods

The major data-gathering methods used in this research were qualitative observations, semi-structured interviews, account holder surveys, and the collection of archival material. Since the project began in 1993, we have conducted repeated observations in a wide variety of settings. This includes over 160 hours of observation in over 40 classrooms in which the Internet was being used. It also includes observation of over 125 meetings between different groups of teachers who have been involved with the project, and dozens of meetings of CK:P's educational and technical support staffs. Dozens of teacher training sessions were also observed. Trained observers used the "full field note" method of data collection (Olson 1976) which involves taking extensive hand-written notes during the events being observed. All notes were made as factual and as concretely descriptive as possible.

To gain insight into participants' perspectives, over 300 semi-structured open-ended interviews were conducted with a wide variety of individuals including over 100 teachers, 30 school district personnel, 14 CK:P staff, and 130 students. Individuals interviewed were selected either on the basis of their role (e.g., all CK:P team leaders and all CK:P educational support staff) or by using stratified random sampling (equal numbers of boys and girls from designated Internet using classes). Numerous surveys of CK:P account holders were also conducted. Although some of them were conducted on line, individuals who did not respond within a given time period were supplied with paper copies of the same instrument. Archival materials, especially e-mail, were another important source of information pertinent to the issues discussed here. With participants' permission, the research team's address was added to virtually all group mailing lists connected with the project. This permitted collection of most normal e-mail between members of the various groups working on this project.

Both field notes and interviews were audiotaped, transcribed, coded and then analyzed using established qualitative methods (Miles & Huberman, 1984; Strauss & Corbin, 1990). In the data analysis, our primary emphasis was on the development and systematic application of thematic categories to all data. Finally, since individuals who have gone to the effort of participating in a competition to bring the Internet to their classrooms might easily inadvertently overestimate its impact, we tried to be especially careful to triangulate different kinds of data to ensure that in addition to teacher reports of such outcomes there was other independent evidence for the outcomes we discuss.

More detailed information about data gathering and analysis can be found in Schofield and Davidson (2000).

Consequences of Teacher Internet Use

Before turning to a discussion of the various teacher outcomes that appear to be stimulated by the availability of Internet access in the CK:P schools, it is important to clarify exactly what we intend to claim here. We are not asserting that Internet access automatically results in such outcomes. Indeed, it appears clear that none of these outcomes are automatic or universal since none of them occurred in every teacher with Internet access that we studied. Neither are we asserting that providing Internet access is necessarily the best nor the least expensive way to foster such outcomes. One can imagine many potentially quite effective ways to foster almost all of the outcomes that we discuss (excluding those relating to increased knowledge of the Internet) that do not involve Internet access. Additionally, we are not asserting that such outcomes occur as soon as access is provided. Indeed, Internet use appeared to be a somewhat evolutionary process, especially in those cases where teachers were initially quite inexperienced with it and its integration into their professional lives. If usage evolves in either kind or amount it is only logical to expect that different kinds of outcomes might occur at different points in time consistent with earlier studies of other kinds of computer use in classrooms (Honey & Henriquez, 1993). Also, it is clear that different teachers made use of the Internet in very different ways and for very different purposes. Thus there is no reason to expect that the consequences of using it should be the same for all teachers

In spite of all these caveats, we believe that this study did yield some useful information about the impact of Internet use on the professional lives of teachers. We now turn to discussing

those outcomes that occurred quite commonly and which appeared to have potential significance for individuals or for the schools they were in.

Increased Work Related Communication with Others

Isolation from their colleagues both within the school and in other schools is a long-standing condition of teachers in this country (Lieberman & Miller, 1990; Lortie, 1975; U.S. Department of Education, 1999). Such isolation is generally seen as problematic because it prevents or at least greatly constricts the flow of information, ideas, and even emotional support that help other professionals to perform effectively. For this reason, one of CK:P's original goals was to reduce such isolation. In fact, reducing isolation was one of the four "educational opportunities" that original grant argued that Internet access could provide.

CK:P appears to have been quite successful in reducing isolation in spite of the many barriers to communication with the outside world in spite of the numerous difficulties that teachers encountered related to scheduling, technical difficulties and other problems (Schofield, Stocks, & Davidson, 1997; Schofield & Davidson, 1997). For example, when educators were asked via survey (N = 325) to describe how use of the Internet had affected the amount of work they did with others in preparing for or carrying out school related tasks, 66% indicated that Internet use had greatly or somewhat increased the amount of this interaction that they engaged in . In sharp contrast, fewer than 2% reported that Internet use had decreased such interactions. Generally consistent with this finding, about three quarters of the educators interviewed intensively on this topic (N = 24) indicated that Internet access had increased their interaction with others. Interestingly , one quarter of these educators suggested that contact with teachers within their own schools had increased because of Internet use. Increased contact with teachers

within their district but outside of the home school (21%), and with educators outside of the district (21%) were also spontaneously mentioned with quite similar frequency. The consequences of this communication were often apparent to researchers since educators not infrequently circulated materials they had obtained from distant others to local colleagues, used it in their classes, and the like.

Although a few teachers also asserted that Internet access increased the amount they communicated with parents or even with certain students, most focused on its impact on interaction with other educators. Teachers often specifically noted that this interaction fostered group cohesion or reduced their isolation as illustrated by the following excerpt from a teacher interview:

> Well, it's certainly increased my connection to people[....]Yeah. I tend otherwise to be a sort of isolated person. I kind of just stay to myself. So it's kind of forced me a bit out of my shell. Without a doubt, it has made me feel more in touch with people.

Of course, not all teachers reported feeling isolated before attaining Internet access. But even these individuals still generally spoke positively of the increase in professional interaction they experienced as a result of Internet use rather than reporting being overwhelmed by it.

Increased Interaction Within the School

Internet access facilitated within school communication in a number of observable ways. At the most basic level it helped to overcome barriers to communication caused by schedule conflicts or by the physical layout of the schools. Educators reported that they used the Internet to reach specific colleagues that they might not have been able to find otherwise without

significant time and effort. Such usage was also apparent in the e-mail that passed between educators in CK:P schools. Another common behavior that increased communication within the school was the use of the Internet for the quick and convenient distribution of information to a relatively large group of colleagues there. For example, one high school teacher sent an e-mail message to all teachers in his school connected with a special program that required students to write research papers. In this message he notified them that students were able to purchase such papers over the Internet. He even listed specific topics closely aligned with the program's curriculum on which he had readily discovered such papers for sale so that his colleagues could avoid these topics or take measures to increase the chances that the papers handed in were the students' own work. Obviously, it would have been possible for him to spread this information by mouth or through a notice physically placed in his colleagues' mailboxes in the main office. However, he found e-mail quicker and easier. Sending this information to a distribution list of colleagues in the special program also ensured that no one would be inadvertently left out of the loop as might have occurred had he decided to mention this personally to each of the teachers involved in the program when he got the chance.

Factors such as the ease of widespread transmission of information clearly contributed to increasing communication between educators in the same school. However, a closer look at the situation suggests that this was far from the only cause. The fact that the CK:P project required that proposals be submitted by teams of educators and that it encouraged multidisciplinary and interdisciplinary work also played a big role in fostering communication and interaction among colleagues within participating schools. For example, even where teamwork was minimal some coordination and collaboration was necessary in deciding what each member would commit to in

the proposal and in figuring out how to distribute the resources flowing to the team from CK:P. Unless the interaction necessary to achieve these purposes came at the expense of other communication with colleagues, which it did not appear to, even this level of interaction increased interaction with colleagues. Furthermore, in many schools communication flourished.

Rather ironically, the fact that a great many individual educators were neophytes at computing in general and with regard to Internet use in particular was conducive to Internet access leading to enhanced communication among them in face-to-face situations. Thus, in many schools dyads or small groups of educators often conferred in person about either technical issues or about educational uses of the Internet. The fact that these educators had committed themselves to undertaking a major new effort without most of them having enough personal knowledge to carry it off individually created a situation in which there was a strong impetus to communicate with each other.

Interestingly, the norms of autonomy, of not asking for help or giving it, which are prevalent in many schools in this project and elsewhere (Hargreaves, 1982; Huberman,1993) seemed somewhat less strong with regard to Internet use than in subject matter areas as the comments of one elementary school principal interviewed during her school's third year in the project suggest:

> And it [the CK:P project] has made a number of them [teachers] more accessible to each other[....] The talk in the teachers' room, the talk in the office here related to[....]computers.... "Well, mine doesn't work that way. What am I doing wrong?" Well, try this. I'll come over to your house and help you out if you need some help."[....]Whereas they might be less willing to ask about a teaching

strategy, [...] they don't seem to be as hesitant to talk about ..something related to computers[...] But that may come...I mean that certainly can come at a later time.

Indeed, perhaps because this is a rapidly developing cutting edge area which was not covered in most teachers' training, many teachers seemed relatively relaxed about admitting ignorance to their peers. Thus, acknowledging the need to learn and working with others in order to fill this need did not seem to be threatening to their sense of themselves as professionals. Rather than being a sign of incompetence, it was often taken as a positive indication of being willing to expend extra effort to master a new tool that many of their colleagues had no idea how to use.

Although increased interaction with colleagues was common, there were striking individual differences in the extent to which this occurred as well as differences between teams in different schools. Specifically, some individual appeared much more willing to seek out help from or to provide help to their colleagues than others. Thus, the increased communication that often occurred in connection with such help generally occurred within subgroups of Internet users, rather than across the entire team as the following quote from an interview with a veteran teacher suggests:

I would say that for those of us using the Internet, it helped build a bond because we did help one another and for those who were more expert at using the Internet and html there was more a sense of comradery because of helping one another. And there were those who were rather closed about it...who [....]because of their own time investment and their own expertise were not willing to share[....]There

were those who were willing to share what they learned and those who were not willing to share.

It was not clear whether or not the sharing of information and ideas occasioned by the need to learn how to use computers and the Internet generalized to communication about other work related topics between these same colleagues, a potentially very important outcome. During the time span of our study there was relatively little evidence that this occurred on a broad scale. Indeed, another principal who, like the one quoted above, commented on the increased interaction he observed among his teachers regarding Internet use specifically noted that he did not think it had spread to other kinds of professional interaction by his school's third year in CK:P. However, teachers did report that at least in some cases that talk about the Internet seemed to lay the basis for the development of closer personal relations or a sense of comradery that had not developed previously.

> These guys[....]they'll come over and talk to me and talk about...wiring the room, and getting on line[...] I think it opens things up when other people find out that you have an account or that you know a little bit. They want to come and talk to you all the time [. . .] Some of these guys . . . we have nothing in common but that. [But] you start to realize you have other things in common and, yeah, it just breaks down a lot of barriers. It's really nice.

It is certainly possible that such enhanced personal relations would be conducive to greater professional communication as well, although this would not necessarily follow given the norms regarding autonomy discussed earlier.

Increased Interaction Outside of the School

So far we have focused our discussion on the increase in professional communication and interaction with colleagues within educators' home schools that seemed to frequently result from attempts to use the Internet. However, Internet access also appeared to increase communication between CK:P educators and their peers elsewhere, both within the district and outside it. In fact, 68 % of the educators responding (N = 325) reported "greatly or somewhat" increased contact with outsiders. Just 1% reported that such contact was decreased.

Work related communication with those outside of a specific educator's school had numerous purposes. Communication with those in other schools within the district was often designed to gather specific information on those schools or to learn more about district policies, through informal as well as formal channels. Communications with others both inside and outside of the district had purposes ranging from setting up joint projects to sharing technical expertise, maintaining relationships with distant colleagues, or even arranging for others to pick up materials at a conference for a non-attending teacher's use.

Although most of the increase in communication with those outside of the home school was between educators, there were occasional uses of it by educators to communicate with other kinds of people for a wide range of work related purposes. For example, one teacher e-mailed parents on the spot in front of her class when a disciplinary problem arose, indicating that she felt such prompt action, and the threat of it in the future, helped strengthen her ability to maintain the kind of classroom decorum that she desired. Others used e-mail to contact scientists, physicians, and others about the possibility of serving as mentors for students. Finally, one teacher reported consulting a friend met over the Internet who regularly corresponded with

students in her classes about an occurrence in her classroom which upset her so much she described herself as "hysterical" over it. At the teacher's request the friend e-mailed the student involved and tried to get her to think about some of the issues involved since the teacher felt unable to handle the situation alone. Although this kind of use raises issues regarding students' privacy, it was an interesting case of a teacher's use of individuals available over the Internet as a resource to help handle classroom problems.

Increased Opportunities for Engagement in Professional Development Activities

One major purpose of the increased communication with those both inside and outside of the school, as should be apparent from the preceding section, was for professional development, a term that we will use broadly to refer to efforts by educators to expand their knowledge and skills relevant to performing their work, either as they currently approach it or as they wish to learn to approach it. Consistent with this are the results of a survey of over 500 teachers from all over the U.S. who use telecommunications in their work which found that its use for professional development was common, indeed much more frequent than its use by students in their classrooms (Honey & Henriquez, 1993).

One major kind of professional development that occurred was communication with teachers inside the home school focusing around a very specific kind of learning, the development of technical skills, as discussed elsewhere in this paper in more detail. Work related communication with those outside of the home school but within the school district also frequently concerned the development of technical skills or the solution of technical problems which could be seen as a kind of professional development, assuming the individual learns something in the course of solving a problem. For example, in one nine-month period alone

during CK:P's fourth year, teachers initiated a total of 376 e-mail interchanges, some of them quite extended, with CK:P staff at the e-mail address designed to help with technical problems. Such interchanges covered a broad range of technical topics, but most commonly involved issues relating to Internet applications, to achieving and maintaining Internet access and to networking software.

However, much of the communication with those outside of the school district dealt with broader professional issues, such as subject matter expertise or pedagogical technique. Some of the professional development activities which Internet access to those outside of the school made possible were formal and quite intensive. For example, a small number of teachers enrolled in on-line graduate courses in their subject areas. Other activities were less formal and less demanding, such as participation in newsgroups or list serves designed for or run by educators to discuss pedagogical issues of mutual interest.

Educators' degrees of involvement with such professional development activities outside of their schools varied tremendously from individual to individual. Further, the specific activities they engaged in varied widely. Finally, the quality of the experience varied, as would likely to be the case with non-Internet mediated professional development activities as well. Thus, it is hard to make an overall generalization about the impact of participation in such activities. However, it should be noted that some teachers felt such activities had a major impact on them as illustrated by the following quote from an interview with an elementary school teacher.

> My whole view as an educator, of education per se, has changed, because I feel much more in touch with educators at large because I'm subscribing to list serves.

Such sweeping claims were not the norm, but their potential importance for the individuals involved should not be dismissed.

A very common use of the Internet that could be considered a kind of professional development was exploring the WWW to get specific information or ideas for planning or enriching lessons. This kind of use appears to be common not only among CK:P educators but also among a national sample of teachers as well (Becker, 1999). One new teacher participating in CK:P who found this extremely helpful described his experience this way.

> I'm a first year teacher . . . I could not have pulled this off this year if I hadn't had experience on the Net and knew how to make use of it. Some of the best lesson ideas I've come up with have been sitting late at night at home poking around looking for ideas, and not necessarily on teacher pages, but just . . . looking for resources, exploring for picture prompts, looking for ideas, looking for literature . . . In my mind I've been very successful in here. If I hadn't had that access...I may very well have been a failure in here.

But veteran teachers as well found the Internet very useful in locating information they used in their work as indicated by the following excerpt from an interview with an experienced high school science teacher:

> It's [Internet access] made information available to me that I would have never taken the time or had the energy to find in a library or correspond with another human being about, which was available to me instantly. I mean, I found stuff out that I can't believe I found out.

Interesting, when asked a hypothetical question in a survey about the percentage of teachers who would use the Internet one or more hours per week for professional development if they had access to it in their classroom, educators responding to this question (N = 333) gave a mean estimate of 53%, very similar to the 57 % of educators that these same individuals felt would use it regularly for instruction with students. Some individuals argued that the Internet was conducive to engaging in professional development activities because obtaining help from those at a distance does not threaten one's image in one's everyday workplace as obtaining help closer to home might. Others pointed out the convenience of this kind of professional development since it does not require commuting anywhere and can be done any time that is convenient. Others argued that the vast array of information and assistance available through the Internet far outweighs the resources a single school or even a district could possibly provide. One additional reason for this relatively high estimate of likely educator use of the Internet for professional development is that more than 80% of these respondents indicated that the time they had spent on professional development activities on the Internet was either somewhat or extremely productive.

Increased Knowledge of Computing and the Internet

Teachers' knowledge about computing generally and the Internet in particular were, with some notable exceptions, very rudimentary at the beginning of CK:P. Generally speaking, their level of knowledge increased substantially over the course of CK:P's five year life, although again there were some exceptions. For example, although two-thirds of the educators replying to a survey in the project's fourth year (N = 352) reported that they were novices at the project's inception, only about 15% of these individuals reported that they remained novices. Roughly

70% indicated that they had progressed to an intermediate level of knowledge and another 15% reported having developed advanced skills. Although respondents to the survey, which was administered online, were quite likely to be more sophisticated Internet users than their peers who did not respond, there were many other clear indications of development over time. For example, file servers that were initially located centrally were moved to participating schools. This required that there be at least one person connected with the project at each school with enough knowledge to serve as the site administrator for the file server and to perform various basic technical functions independently. Eventually, each of the participating schools was able to find or develop such capacities among the team members, in spite of the fact that many teams would clearly not have been able to do this at the project's inception.

Further suggesting substantial technical learning, 60% of the teachers (N = 43) who were interviewed during their first year with CK:P and asked to indicate what they believed to be their greatest accomplishme0nt connected to the project mentioned an achievement relating to growing technical comfort or competence. A smaller but still substantial 38% of the teachers (N = 42) interviewed in their second year with CK:P did the same. A larger proportion of them than of first year teachers mentioned curricular or students' outcome. Teachers in their first year with CK:P were especially likely to mention change in their level of comfort with using technology. The following excerpt from an interview with an educator in an elementary school is quite typical:

> Interviewer: As you think back over your experiences using the Internet since last spring, what would you say your biggest accomplishments have been?

> Well, I don't know if I would call it an accomplishment, but being so comfortable with it now. Before it was...I had an account, but I could never remember my password. I could never remember what I was supposed to do. I would have big problems with it, and I couldn't figure out whom I was going to write to anyway if I (laughs)[...]And now it's just being able to subscribe to some of these lists and start to communicate with people [....] I've come a long way on doing that. [....]I think my biggest accomplishment is being able to get in there...and comfortable, and use it on a daily basis now[....]to the point that I can't imagine not having it.

Such a change was important because it helped to overcome an important barrier to use and opened up new possibilities for teachers to begin to find ways in which the Internet could serve them and their students. Furthermore, such exploration often led to an increase in technical knowledge which in turn led to even more exploration and the additional growth of technical skills.

Some of this increase in comfort with and knowledge about how to use the Internet was facilitated by formal professional development activities such as enrollment in courses at local universities or over the Internet. However, enrollment in this kind of major formal learning experience was relatively rare. Furthermore, the individuals who engaged in such activities tended to have at least a moderate amount of technical knowledge already. Much more commonly, the increase in knowledge about computing and the Internet appeared to stem from other experiences.

CK:P's extensive training activities played an important role in developing teachers' knowledge in these realms. A wide variety of training mechanisms were used in CK:P and a

CK:P's extensive training activities played an important role in developing teachers' knowledge in these realms. A wide variety of training mechanisms were used in CK:P and a large number of teachers participated in them. For example, a course given for graduate credit by the CK:P staff called for a considerable investment of time and energy. Although it was offered in CK:P's second year when only eleven teams had been selected to participate in the project, over 90 educators enrolled in it. Inspection of records and interviews with the educational staff suggested that by the project's fourth year the education and technical staff had provided at least some technical training to educators at over 80% of the schools in the district and that they had provided relatively intensive training (from five to ten instruction sessions) for participating faculty at 18 of the 20 sites accepted into the project by this time. In addition, the CK:P staff provided technical support an average of at least once a week to someone at 19 of these CK:P sites and occasional support to the one other CK:P school.

Of course, the mere fact educators received training and support is not conclusive evidence that learning occurred. However, a number of factors suggest that it did. First, although educators were not paid extra for participating in most of these training activities and generally did not receive any other sort of compensation for attending them, interest in them was very high. Indeed, typically these courses were over-subscribed, with many individuals desiring to participate having to be turned away. This suggests that teachers found these experiences instructive enough to give up what would otherwise have been their free time on afternoons, evening and weekends. Second, attendance at such training sessions often preceded individual's successful assumption of new technical responsibilities or their involvement in activities using the Internet that they had not been able to carry out before. This too suggests that these

experiences resulted in learning. Finally, surveys were conducted of participants in some of these activities. The results of such surveys uniformly suggest that participants believed participation in such activities did indeed increase their skills, even when the training was relatively brief. To give just one straightforward example, participants in a two day summer workshop held shortly after their teams had been accepted into the CK:P program showed statistically significant gains in self-reported proficiency in Internet use from before that workshop to after it, $F(1,22) = 5.07$, $p \leq .05$.

Also very important in developing the technical skills of teachers at many schools were activities of other CK:P team members that ranged from informal consultation with and support of colleagues to more formal training activities initiated by team members for their colleagues. Although the amount of such activity and the extent to which it was confined to members of the CK:P teams varied dramatically from school to school, such activities commonly played an important role in helping teachers increase their knowledge of computing and the Internet. Educators responding to the on-line survey mentioned earlier in this chapter reported that they had supplied either formal or informal Internet assistance to a median of six colleagues within the district. For example, teachers at one school set up a series of lunch time meetings run by team members with substantial technical expertise to help pass on some of that knowledge to interested colleagues both inside and outside of the CK:P team. CK:P team meetings at this and other schools were also often the occasions for additional informal assistance that teachers reported was very useful to building their Internet-related skills. Finally, a lot of informal assistance occurred in the context of small groups of teachers or even dyads. For example, in an informal update of the CK:P project status circulated by e-mail among team members at one of

the participating schools, one of the teachers wrote, "Marge (the librarian who was a member of this particular team] has shown me how to reset passwords in case of need, but I have yet to get the directions in writing[....]Marge, could you send me the direction by e-mail , or make a copy of the page you have? Thanks."

Another factor contributing to the growth of technical expertise among educators was home computer access. Feeling strongly that home access was important for building expertise, the education staff willingly assisted teachers in learning how to use modems and even went so far as to make house calls when necessary and feasible. Indeed, more than 200 respondents to a survey during the project's fourth year (N = 325) reported having received personal assistance facilitating home computer access to the Internet from the CK:P staff ranging from brief phone consultations to home visits.

It must be noted that just as attendance at training courses does not necessarily result in learning, so the purchase of a home computer does not in and of itself build technical expertise. However, as with attendance at training sessions, there were clear indications that such a connection did exist. First, it is clear that home computers were used a substantial amount to access the Internet as evidenced by messages relating to such use sent to the CK:P on-line help facility as well as frequent conversations among CK:P teachers about such use. Such use alone seems likely to have some positive impact on skills in a population that generally speaking started out with very little technical knowledge and virtually no experience with the Internet. Furthermore, it was not uncommon for educators to indicate that they were able to call upon family members, including their children, to help teach them how to do things with the Internet that they themselves did not know how to do, which also suggests learning. Finally, educators

also frequently mentioned that home computers were good resources for learning because their time at home was not so heavily obligated or as tightly scheduled as it was in school, making it a good place to engage in the time-consuming process of increasing their skills. Thus, home access appeared in many cases to make a significant contribution to the increase in educators' ability to use the Internet that was evident during the course of the CK:P project. Consistent with this is Becker's (1999) finding that home Internet access is an important predictor of teachers' professional use of the Internet.

Home Computer Purchases by Educations

A large number of network team members purchased computer equipment for their homes, most especially modems, with their own money during the course of the CK:P project. Early on in the project demand for information about what hardware to buy was so great that on a number of occasions CK:P staff seriously discussed the desirability of putting information on-line about the advantages and disadvantages of different set-ups. One member of the education staff estimated that by the end of the project's first full academic year of operation it had stimulated the private purchase of $1,000,000 worth of computer equipment by teachers. We have no way of determining precisely how accurate this estimate is, and it may well be too high. However, two factors taken together suggest that even if it was an overestimate the claim of substantial personal expenditures was not without foundation. First, the individual making this estimate was very familiar with the equipment purchases made by network team members since educational staff members were frequently asked for advice on hardware purchases or for information on installing modems, configuring SLIP connections, and the like. Second, a survey conducted roughly one year later of all individuals with CK:P-sponsored accounts found that 74

percent of respondents (N = 450) reported having spent at least some of their own money to purchase new equipment in whole or in part to connect to the Internet since receiving access through CK:P. The most commonly reported amount spent at the time of this survey was about the cost of a modem (between $100 and $250). In addition, 30 percent of the respondents reported spending $1,000 or more, suggesting the purchase of a home computer. In all, individuals who responded to the survey reported spending a total of more than $440,000 since the project's beginning on equipment that would enable use of the Internet. Although this estimate was obviously much lower than that given by the education staff member a year earlier, it should be kept in mind that expenditures of individuals not responding to the survey are not included in it. Given the likelihood that those more involved with CK:P in particular or with WAN in general were probably more likely to respond to the survey, it would be misleading to extrapolate to the entire population of account holders from this subsample. However, given that only about 40 % of account holders replied to the survey it seems reasonable to assume that actual expenditures were substantially above this figure.

A similar survey conducted two years later also suggested substantial expenditure of personal funds. There, roughly 50% of the respondents (N = 352) reported spending more than $1,000. The total reported expenditures were roughly one million dollars, again most likely an underestimate because many participants choose not to respond to the survey.

At school after school, educators reported a large number of teachers buying home computers or upgrading equipment in order to be able to use the Internet as a direct result of participation in CK:P. It is true that during this period there was a very substantial growth in the number of home computers in the U.S. generally (Hoffman & Novak, 1999) and also a

tremendous growth of interest in accessing the Internet (McConnaughey & Lader, 1997). Thus, it is impossible to know exactly how much of this shift was due to CK:P, but respondent after respondent suggested such a connection using words like those below of an high school librarian and an elementary school teacher:

> Because of Common Knowledge: Pittsburgh, that's why I bought my first computer...my home computer.
>
> When we wrote the grant[....}our support specialists helped guide us through this and our principal.... And when we got the grant, I would say we had maybe one teacher or two teachers with [home] computers. Now I would say...ninety percent have them[....] We all went out...like I went out and I got a new one[...]so I could have a modem.

In addition to expending personal funds, teachers who bought new equipment invested time at home learning to use their equipment and to navigate the Internet. The number of individual teachers and librarians in the district logging onto the computer that served as the main file server rose from only about 35 per month just after the first training sessions in the spring of CK:P's first year to between 524 and 566 per month three years later. On average, teachers spent more time on-line during non-working hours than they did during school hours; further, the total non-school login time for teachers increased steadily over the course of the project. Although a substantial amount to the time they spent on the Internet at home was devoted to personal pursuits, there were numerous indicators that account usage from home was frequently focused on professional purposes . First, teachers reported such use to researchers, making comments like the following:

It's been very exciting. It's inspiring to get on the Relay Chat and be able to communicate with people in France in French. It can be very motivational ... And if it's motivational for me, it';s going to be motivational for my students as well. So I think that's been very, very exciting.

Second, the educational staff also heard such reports in the context of requests for assistance in accessing given web sites or performing certain functions with home machines. Third, teachers sometimes referred to such activities in casual conversations with colleagues, circulated work related materials to colleagues from home machines, or brought in work related materials printed on home printers, all activities suggesting that home computers were being used in the pursuit of professional goals.

Expansion of the Teacher's Role Outside of the Classroom

The core of teachers' work is helping their students to learn. But teachers' jobs generally entail at least some other activities, such as building and maintaining community support for the schools through interaction with parents and contributing to the school through committee work. Many teachers involved in CK:P began to assume new and different non-classroom roles as a result of their involvement with Internet use. Although these roles were generally not absolutely unheard of for teachers in the district prior to CK:P, they were quite uncommon and a substantial number of teachers had their first experience in some of these roles in connection with their Internet use. A teacher who engaged in an unusual number of such activities talked about them in an interview:

We have , in the United States, approximately 400 physics teaching resource agents, of which I'm one[....]We'll e-mail back and forth[....] I am in constant

touch with colleagues at the [state] Department of Education on test development. I'm on one of their test development teams[....]One of the team members is a very active elementary school science teacher, and she and I are constantly having exchanges over the web--things that she can do with the kids to get them ready of different activities, suggestions for different activities{....}I'm making things available to the whole group that I'm working with at the state though a mailing list on things that I come across and that's something that I would not even have any contact with if it hadn't been for Common Knowledge[...]If it depended on me to do it by mail and phone, it would never get done.

As is apparent from the above, these roles were quite varied. Generally speaking, the particular role or roles assumed by individual educator appeared to depend on a variety of factors including their specific interests and talents, the time they had available for such new roles, and the needs of the school in which they worked. Quite a number of teachers became peer trainers in a fairly formal way, serving as leaders in training sessions for other educators both inside and outside of their schools. In this capacity they did things like make decisions about the material to be covered, prepare oral presentations, and construct written materials to guide their peers' learning. Given the prevailing norms regarding autonomy and privacy that were evident in CK:P schools as they are elsewhere (Huberman, 1993; Zahorik, 1987; Zielinski & Hoy, 1983), assuming the role of peer trainer, whether formal or informal, was quite a break with the past for many teachers. Yet, some even actively sought out such opportunities. For example, one particularly active Internet user from a first year site specifically asked a member of the CK:P education staff if she and some of the others from her team could participate in helping to train

teachers just joining the project. The staff member excitedly replied in the affirmative, saying that he had been planning on asking them to do this, but that he had been hesitant to do so because he was not sure they would want to help out in this way.

Another common role that emerged, most likely mainly because the CK:P project was structured in a way that required it, was that of the school based network administrator. Individuals serving in this role generally found that they had to learn a substantial amount to perform it adequately, but were self-selected from among the relatively small subgroup of teachers who were personally interested enough in the technical aspects of computing that this was seen as a desirable challenge rather than an insupportable burden. Fortunately for the project, most schools had at least one or two such individuals. Serving in this capacity usually brought a certain amount of collegial recognition of the teachers' expertise, a finding very similar to Evans-Andris'(1996) finding that teachers who embrace computers and become technical specialists often gain occupational rewards ranging from status within their schools to promotions to the position of computer coordinator. On the other hand, one problem that arose was that these self-selected technical gurus were occasionally more intrigued by the technical aspects of the work than by their potential as educational tools. As one member of the education staff put it:

> If anything they like that part of it (the technical aspects) more than they like the part of implementing it into content because the people who gravitate to that like to play with the machines anyway.

Other teachers assumed very different kinds of new roles. Many of these involved becoming information providers to new constituencies outside of the school district. For

example, a small number of teachers and librarians became sufficiently involved in using the Internet in their work that they made presentations on their work at regional or national professional meetings. Enough interest was generated by at least some of these presentations that participating educators were asked to engage in follow-up activities such as sharing their acceptable use policies. In addition, some teachers became information providers in new ways much less analogous to classroom teaching than becoming a peer trainer or giving a conference presentation. Some became curriculum developers by posting for others on the world wide web lessons that they had developed for their students that made use of the Internet. Although teachers were quite used to developing plans for classroom activities for their own students, it was very much less common for them to formally present these plans for others' consideration for adoption. Some of the new information provider roles that emerged were quite unique and almost impossible to have predicted. One educator was inspired by her work on the Internet to begin writing children's books, something she had never done before. Another CK:P teacher solved a 20 year old medical problem with information he found on the Internet, an occurrence he termed "a miracle." In fact, he was so grateful for this that he constructed a web page about this illness in conjunction with a physician in the hope that it would help others suffering from the same affliction.

Other teachers became resource providers to their own schools in a new way as a result of CK:P. For example, one reaction of teachers to not having been selected to become part of CK:P in spite of having applied to the project was to begin to try to raise funds to increase Internet access for their schools by other means, such as applying to local foundations or approaching businesses for assistance. These activities were occasionally constrained by the

district because of fears that they would interfere with the districts' own centralized fund raising activities, which not surprisingly caused considerable frustration on the part of the educators involved. However, some were able to find ways to acquire additional computers or to expand Internet access that were acceptable to the district.

Undertaking almost all of the new roles described above demanded considerable time and energy. Furthermore, release time from teaching in order to carry out such activities was rare with one exception - those assuming system administration responsibilities did get release time in numerous schools. Thus, many of the teachers assuming these roles ended up dedicating personal time to them on evenings and weekends rather than being able to fit this work readily into their already busy schedules during the school day. The fact that CK:P participants were all volunteers may mean that they were the kind of dedicated and energetic individuals predisposed to taking up such challenges and that such behavior might not be as common among a broader group of teachers. Interestingly, Becker's (1999) survey of a national sample of teachers suggests that it is teachers who are already predisposed to involvement in leadership activities who are most likely to use the Internet in their work. Nonetheless, for many of the CK:P teachers involvement with the Internet through CK:P led to their assuming the kinds of roles described above for the very first time.

Increased Professional Pride and Enthusiasm

The outcomes for teachers discussed above include a substantial amount of new learning and a broadening of their professional networks and work activities. Not surprisingly, then, many of the educators involved with CK:P felt that their professional capabilities were expanding. One common response to such perceptions was pride in their ability to master new

challenges and increased energy and enthusiasm for their work. Indeed at a conference held in CK:P's forth year to showcase the project to individuals from around the country, the participant who served as a reporter to the larger group about the content of a workshop run by CK:P librarians indicated that the most striking aspect of their presentations was the evident pride that the librarians appeared to feel in their work, and the sense of personal growth and development which was apparent in their presentations. This sense of pride was also clear in interviews with teachers:

> Interviewer: What would you say has been your biggest accomplishment since last spring?
>
> Ms. Widner: ...to become familiar with the Internet and to get to the point where I was able to find things...that I could tie in with the curriculum. I found that very pleasing and very satisfying...I felt as if I was somewhat on a leading edge ....Yes, I'm very...very proud to be part of that whole (effort).

Note in the interview excerpt above that both technical learning and the ability to use the Internet to function better as a professional were mentioned. Both of these were common themes. For many educators the sense of pride was connected to the fact that they had proved their ability to learn about cutting edge technology that had once seemed threatening and difficult. Given the sense of trepidation that was expressed by so many educators early on about such learning, it is important to note that generally it did not take them too long to learn what was necessary to feel that they could make at least some productive professional use of the Internet. For example, 21 of the 28 participants in a five-day summer work shop replied affirmatively to a question about whether or not they that they felt ready to incorporate Internet into their

"Yes, because I've had a really good experience with this once I got on-line. This has given me a new lease on teaching - a new way to do the job that may be fun," were common. Only 5 individuals qualified their affirmative answer with comments like, "Yes, but I'm still unsure of the extent of my knowledge." Not a single one of the 26 respondents reported feeling completely unprepared. Although many of these teachers still had relatively rudimentary technical skills, the fact that they were able to learn fairly readily how to accomplish valued ends appeared to create a sense of pride in themselves and their work.

The enhanced sense of pride and enthusiasm seemed not only to be related to a perception of increased technical competence, as indicated above, but also to the sense that Internet use would help teachers to perform their work in a way that would be beneficial to their students and/or to themselves. Internet access helped many teachers take some steps along paths that they wanted to travel in their teaching, a very important outcome that we discuss at length elsewhere (Schofield & Davidson, 2000). Also, it gave many access to new resources which they believed enlivened and enriched their teaching. In addition, it often improved student-teacher relationships and thus created a more pleasant classroom climate which reinvigorated some teachers (Schofield & Davidson, in 2000).

Renewed pride and enthusiasm were not only reported frequently by teachers reflecting on their experiences with CK:P. It was also quite frequently noted by principals. For example, one principal asserted that Internet access "gets them [teachers] out of the same old rut," and another noted that it refocused teacher conversation from constant complaints about "kids driving me crazy" to lively discussions of what they were accomplishing as part of CK:P and how to

solve the technical problems they were encountering. Thus, this change in emotional tone was apparent not only to the individuals experiencing it but also to others with whom they worked.

Conclusions

There appear to be a number of potentially important outcomes for teachers flowing from Internet access within the context of the CK:P project. Specifically, such access appeared to increase work related communication with other professionals. Although some of this increased contact was with those outside of their schools as would expected, more surprisingly a substantial increase in contact with others within their school was also common. Much of this communication occurred in the context of their increased involvement in an expanded set of professional development opportunities. In addition, teachers, many of whom were neophyte computer and Internet users, acquired a substantial amount of knowledge about how to use Internet technology in their work. Further, a smaller number of teachers experienced notable expansion in the kind of professional roles they played outside of the classroom. Finally, a strong sense of enhanced pride in and enthusiasm for their work was evident in many educators teachers as a result of their involvement with Internet use.

Although the preceding paragraph summarizes the conclusions presented in this paper, it is important not to draw inappropriate inferences from it about the consequences of Internet access. For example, it is not only possible but likely that specific characteristics of the CK:P project played a role in fostering many of these outcomes. For example, CK:P required that educators apply for Internet access as members of a team. Thus, the structure of the project set the scene for the development of increased communication among educators within particular schools. Similarly, CK:P provided a great deal of support and technical assistance to teachers

which undoubtedly helped to account for the impressive gain in Internet-related skills that many teachers experienced. CK:P's use of volunteer educators may also have played a role in setting the scene for the marked expansion in teachers' non-classroom roles through self-selection into the project of individuals who were particularly motivated and energetic. Thus, we wish to emphasize that it is not Internet access in and of itself, but access within a specific context, that yields the outcomes described here.

Further, it is important to call attention to the fact that the extent to which many of these outcomes occurred varied from school to school or even from teacher to teacher within schools. Thus, even within the context of a uniform set of surrounding factors at the project level there were many variations at the school and classroom level that influenced the extent to which the outcomes discussed occurred. In sum, although we have chosen to focus on outcomes that seemed quite widespread, none of the outcomes discussed here is guaranteed.

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